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ABSTRACT

A total of 41 preschool children, either 2 or 3 years of age, and their mothers were randomly assigned to two treatment groups: a microworld computer experience designed to teach the concept of inside/outside and an alphabet computer experience designed to drill ABC's. Videotapes of mother/child dyads were coded and scored using a revision of the Wood and Middleton (1975) Assisted Problem Solving Scale; interrater reliabilities were over .80. Children were administered a sorting task at the end of treatment. Data analysis revealed the following: microworld mothers relinquished control of software to children as competency developed; depending on the type of software, mothers used different intervention strategies; and age of child influenced intervention strategies. A 2 x 2 ANOVA yielded no significant main effects for group or age on the posttest. However, the age x group interaction approached significance with 3-year-olds in the microworld group correctly classifying more objects. A repeated-measures mixed model ANOVA revealed a highly significant within-group effect for age on number of correct object placements per day. The 3-year-olds in the microworld group were significantly more successful in classifying than were the 2-year-olds. Recommendations were made concerning successful child/computer interactions. (Author/RH)

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Abstract

Forty-one preschool children, 21 two-year-olds and 20 three-year-olds, and their mothers were randomly assigned to two treatment groups: a microworld computer experience designed to teach the concept of inside/outside and an alphabet computer experience designed to drill abc's. Videotapes of mother/child dyads were coded and scored using a revision of the Wood and Middleton (1975) Assisted Problem Solving Scale with inter-rater reliabililties over .80. Children were administered a sorting task at the end of treatment. Data analysis revealed the following: microworld mothers relinquished control of software to children as competency developed, depending on the type of software different mother intervention strategies were used, age of child influenced intervention strategies. A 2x2 ANOVA yielded no significant main effects for group or age on the posttest. However, the age*group interaction approached significance ($p < .053$) with three-year-olds in the microworld group correctly classifying more objects. A repeated measures mixed model ANOVA revealed a highly significant within-group effect for age on number of correct object placements per day. Three-year-olds within the microworld group were significantly more successful than two-year-olds. A number of conclusions were drawn and reccomendations made concerning successful child/computer interactions.

In Mother's Lap: The Effect of Microcomputers on
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Present controversy over the microcomputers monster/messiah characteristics (Shepard, 1980), premature conclusions that preschool children should not work with computers until reaching the concrete-operational stage (Barnes & Hill, 1983), and recent re-evaluation of the preschool child's cognitive abilities (Gelman & Baillargeon, 1983) lead to the formation of this study. The issues surrounding microcomputer use by preschool children are many (Barnes & Hill, 1983; Cuffaro, 1984; Lawler, 1982a; Papert, 1980a; Shade, Nida, Brinkley, & Watson, 1985). Wartella and Reeves (1982) have noted that controversy is typical of the emergence of any new educational media and that no previous media has ever fulfilled the potential claimed by it's proponents. What then should be made of the recent debate on computer intervention for young children? As Dickson (1983) pointed out, it is already too late to address the fundamental questions. With millions of microcomputers in homes and preschools (Bell, 1983; Dickson, 1983; Study Finds, 1982; Wrege & Watt, 1982), many are already in the hands of young children. Therefore, investigations of computer use by young children should revolve around two central issues: the

young child's capacity to deal beneficially with this new technology and the parent's ability to facilitate their child's efforts.

Young Children and Computers

In spite of the observational, anecdotal nature of much of the current research involving young children and microcomputers (Brady & Hill, 1984) enough replications have occurred to draw some tentative conclusions about the appropriateness of interfacing young children with microcomputers. For example; it has been established that preschoolers can indeed work with standard keyboards and other parts of the computer configuration (Borgh & Dickson, 1983; Muller, 1983; Rosen, 1982; Shade, Daniel, Nida, Lipinski & Watson, 1984; Swigger & Campbell, 1981; Watt, 1982). Many of the preschool children in these studies: turned the machine off and on, removed and replaced diskettes properly, followed the instructions of a 4-choice picture menu, changed programs (disks) as often as three times in a ten minute period, worked at the computer together in naturally occurring dyads, spent a great deal of their time talking about the computer activity, and exhibited a great deal of prosocial behaviors (turn-taking, helping, sharing). Furthermore, children in high quality care settings have been observed to work together at the computer with minimal instruction and supervision. Limited work in this area has been done with children under three. However, Dickson (Reed, 1983) and diRenzo (1983) have both shown that

children 18 to 24 months old can master a similar variety of computer operating skills in a short period of time.

It can be seen from the above that, contrary to premature warnings (Barnes & Hill, 1983; Cuffaro, 1984), the microcomputer can be accessible to young children. It is necessary to point out that accessibility is determined by software choice. Software that is age-appropriate or accessible allows a young child to interact with a microcomputer in spite of his/her developmental limitations. Usually such merely requires single-digit pressing of a few particular keys.

In spite of the evidence presented above, a major criticism of computer use by young children centers around the following issue (Barnes & Hill, 1983; Brady & Hill, 1984; Cuffaro, 1984): that preoperational children cannot deal with an abstract presentation of material (two-dimensional graphics). Given the current lack of empirical evidence to support this assumption, it is incorrect to presume the preoperational child incapable of any of the "concrete operational" tasks thought necessary to benefit from computer interactions.

Preoperational Development

It has long been thought that children develop cognitively through a series of stages from sensorimotor development to formal operations (Piaget, 1952; Piaget, 1970). Cognitive psychologists questioned the concept of stages (Flavell, 1977; Rohwer, Ammon, & Cramer, 1974) and early on

concluded that sufficient evidence existed to show that important cognitive changes are marked by a slow, gradual process rather than the abrupt changes implied by Piaget's theory.

Recently Gelman and Baillargeon (1983) conducted an extensive review of the research related to the concept of stages. Citing numerous research studies they concluded that prechool children can take another's perspective, are not so perceptually bound as predicted, and are often able to detect reciprocal transformations. Gelman and Baillargeon further concluded that the mentality of the preschool child is qualitatively more similar to that of the older child (concrete operational) than Piagetian theory leads one to believe.

Of the several domains of cognitive development available, simple classification was chosen as the vehicle for demonstrating the ability of preoperational children to think concretely enough to benefit from computer interactions.

Classification

Inhelder and Piaget (1964) stated that classification begins when children group together objects that are similar in some way. However, they are not willing to credit a child with the ability to classify unless certain criteria are met. Because the young children (under age 5) in Inhelder and Piaget's study of over 2000 children, classified according to configural variables or what they termed "graphic"

classifications, Inhelder and Piaget concluded that the preoperational child was incapable of true classification. Yet, a good deal of recent research has shown that young children can indeed classify objects taxonomically (Fisher & Roberts, 1980; Mervis & Crisafi, 1982; Nelson, 1973; Ricciuti, 1965; Rosch, Mervis, Gay, Boynes-Braem, & Johnson, 1976; Ross, 1980; Stott, 1961; Sugarman, 1975, 1979). Several of these studies (Mervis & Crisafi, 1982; Rosch et al. 1979; Sugarman, 1979) have shown that the young child's ability to classify depends on the level of stimuli they are shown (basic, superordinate, subordinate). The work of Fisher and Roberts (1980) found that children as young as 15 months sort single categories like blocks that vary along one dimension (circles from squares). They further found that as children matured they could classify more complex arrays and concluded that children acquire classificatory skills in gradual steps which contradicted Inhelder and Piaget (1964). Sugarman (1975, 1979) has on two occasions investigated the ontogeny of classification skills in children three and younger. She also found that between the ages of 1 and 3 children begin to classify and improve rapidly in their ability to do so.

Finally, it is interesting to note the work of Nelson (1977). She presented infants (24 months) with a shoe and a cup; and observed that the infants tried to put the shoe on or drink from the cup. Gelman and Baillargeon (1983) noted this to be an example of infants assimilating novel objects

into existing sensorimotor schemas. In their terms this was a "primitive form of classification." Although evidence has been presented to show contradictions between Piagetian stage theory and current classification studies, this final bit of evidence has an uncanny agreement with an earlier statement made by Inhelder and Piaget (1964). They cited as evidence of classification the following:

If a child enters a room with a chair in it and names it "chair," or otherwise acts in a way which implies that he recognizes that it is a chair (sitting down in it), then we . . . infer that in one sense he has classified the object as a chair (p. xii).

Mother's Role

Mothers were chosen to work with their children in this study for several reasons. They were the individuals to whom the children were most attached (Ainsworth, 1979), they were necessary to fulfill what Bronfenbrenner (1979) referred to as the primary context of learning, and finally Wood and Middleton (1975) have shown that mothers are the best "natural" teachers of their children.

Ainsworth (1979) emphasized the importance of the mother/child relationship when she showed that infants with a strong attachment to mother will explore a strange environment while those with weaker attachments do not. The importance of the mother/child relationship has further been underscored by Ladd and Mize (1983). They stated that a

positive interpersonal relationship between teacher and learner "may well influence every aspect of the skill-training process (p. 153)." This is based on the assumption that children will pay closer attention when the teacher is trusted and well-liked. Bronfenbrenner (1979) has referred to this relationship as the "primary-learning context." He explained that in this context a child is allowed to observe and engage in ongoing patterns of progressively more complex activity jointly or under the direct guidance of persons who possess knowledge and skill not yet acquired by the child and with whom the child has developed a positive emotional relationship.

Wood and Middleton (1975) have further hypothesized that mother, because of her general knowledge of her child, would "know" the best level at which to intervene in a teaching situation. They have noted that mother often intervenes to help the child by taking over one or more operation. By doing so, she frees the child to concentrate all his/her attention and effort upon a narrower range of alternatives within the task. This "region of sensitivity" was defined as the boarderline between what the child is currently capable of doing and what s/he cannot. Vygotsky (1978) called this the "zone of proximal development" and defined it as the distance between the actual developmental level and the level of potential development; or those functions that have not yet matured but are in the process of doing so. Wood and others (Wood & Middleton, 1975; Wood, Bruner, & Ross, 1974)

have shown that mothers and teachers of 3-to 5-year-olds who concentrated their attention and activity upon this region were consequently the most effective instructors. This behavior has also been termed "other regulation" by Wertsch (1978). Since we were dealing with very young children it seemed essential to have mother's expert help.

Research Questions and Special Terms

This study proposed to design a microworld in which very young children, 20 to 36 months, could exercise powerful ideas that relate to the development of concept formation and pre-classification or sorting skills. Papert (1980a) defined a microworld in the following terms:

A subset of reality or a construct of reality whose structure matches that of a given mechanism so as to provide an environment where the latter can operate effectively. The concept leads to the inventing of microworlds so structured as to allow a human learner to exercise particular powerful ideas or intellectual skills (p. 204).

In other words, a microworld is a simulated environment where children have direct access to particular concepts and the ability to manipulate those concepts in meaningful ways. In other words, "a microworld embodies the simplest model than an expert can imagine as an entry point to richer knowledge (Lawler, 1982a)."

In light of the controversy presented above and the constant pressure to interface children with computers at

ever younger ages (Study Finds, 1982; Wrege & Watt, 1982), this study was undertaken. More specifically it was intended to investigate several issues related to the above reviews. For example; can a child (age 20 months to 36 months) learn to work a microcomputer? Can mother, with the aid of age-appropriate software, teach her child to use a microcomputer with only minimal training? How do mothers go about teaching their child when a microcomputer is present? Will software type have an effect upon mother's teaching strategies? And finally, is a microworld an effective way to develop concept formation and sorting skills in young children?

Methods

Subjects

The subjects involved in this study were 46 preschool children enrolled in a university one-hour enrichment program and their mothers. Children attended this program twice a week. While the children explored a Piagetian-based play-school environment, mothers attended a one hour lecture on various child development topics. There were two groups of children, two-year-olds and three-year-olds with mean ages of 2.01 and 2.83 respectively. Of the original 46 children, five did not participate. Children were randomly assigned to either the microworld or alphabet groups. There were 10 twos and 11 threes in the microworld group and 11 twos and 9 threes in the alphabet group. In terms of gender, there were 11 males and 10 females in the microworld group; while the alphabet group had 12 males and 8 females.

Insert table 1. about here

Pilot Study

A pilot study was performed to preassess a similar population's knowledge of the concept inside/outside and their familiarity with the objects that were utilized in the microworld group. The pilot study was performed on an equivalent group of 23 preschool children. Children were shown pictures of 30 different objects and asked if they knew what it was. They were then asked if the object belonged inside- or outside-a-house. It was concluded that children between 18 and 24 months did not know the concept as they indicated that things belonged either inside or outside. Between 24 and 36 months children generally knew the correct classification for 1 to 3 items. Between 36 and 42 months most children did very well. These pilot results were much as might have been predicted by the work of Sugarman (1979). Ten objects, five inside and five outside, that were consistently incorrectly identified were chosen and incorporated into the microworld.

Treatment

The microworld group interacted with specially developed software (using SpriteLogo for the Apple IIe) centered around the inside/outside concept. The intervention, made up of four 15 minute sessions, lasted for one hour. Children, sitting in their mother's lap, worked at an Apple IIe with

dual-disk, an Amdek color monitor, and SpriteLogo interface card. The screen background, drawn by the turtle, contained the cutaway of a five room house surrounded by green grass and blue sky. All keys were covered with blank stickers except for the following. Ten keys were covered with pictures of the objects they controlled: five inside objects (table, lamp, bed, TV, potty) and five outside objects (car, swing, slide, fence, stop sign). Four additional keys functioned as manipulators for the graphic objects. These keys had arrows on them. Finally, there was a "stop" and "go" button. The go button caused the software to function by animating the objects. When a mother/child dyad was satisfied with object placement, they could press the stop button to fix the object in place, press another object key, press the go button, and begin manipulation again. When complete the monitor screen displayed 10 objects in varried positions in and out of the house.

Children in the alphabet group worked with software designed to drill the abc's. Pressing any letter key would cause a highly colorful, animated cartoon corresponding to that letter to appear on the screen; any letter key worked. "Stickybear ABC's" was the software utilized.

Design

The design utilized in this study was mixed. As such it included elements of a Posttest Only Control Group Design (Campbell & Stanley; 1963) as well as repeated measures. The subjects constituted a convenience sample. They were not

randomly selected although randomly assigned to groups. The sessions with mother and child interacting together at the microcomputer were videotaped from closed circuit cameras and observed from behind two-way glass.

Three independent variables were of interest: treatment group, age, and mother's teaching behavior. This third variable was measured using an adaption of the Wood and Middleton (1975) Assisted Problem Solving Scale. Four levels of intervention were coded: 1) No intervention. 2) Verbal instruction. 3) Indicates materials (pointing), and 4) Demonstrates. Inter-rater reliability consistently exceeded .80.

There were essentially two dependent variables of interest. The first was the total correct responses on the posttest (a sorting game patterned after the microworld software). The second was the total daily number of objects correctly placed inside or outside the house while playing with the software. Several other scores were obtained as well: frequency of mother intervention at each level, the frequency with which a specific intervention level resulted in child success, the amount of time mother spent in the region of sensitivity (the borderline between what a child can and cannot do). It was also calculated each time child success led to lower intervention (mother did less) and each time child failure led to higher intervention (mother did more). These scores were analyzed using a variety of methods with the SPSSX statistical package (Nie, 1983).

Results

Data analysis revealed the following information. Sign tests showed that microworld mothers gave significantly more control over software manipulation to their children between day one (D1) and day four (D4). Specifically the following changes in mother intervention strategy were noted: 1) Mother indicates materials decreased (D1 = 24.71, D4 = 36.57, $p \leq .0266$); 2) Mother demonstrates decreased (D1 = 38.52, D4 = 23.71, $p \leq .0004$); 3) Mother verbal instruction increased (D1 = 16.81, D4 = 36.57, $p \leq .00005$); 4) No mother intervention increased (D1 = 3.38, D4 = 11.43, $p \leq .0002$). There were no significant differences for the alphabet mother's intervention strategies between day one and day four.

Kendall's Coefficient of Concordance (microworld's $W = .58$, $p \leq .00005$; alphabet's $W = .55$, $p \leq .00005$) revealed significant agreement among children's behaviors in both groups as to which mother intervention strategy produced the most success. However, the children's rank ordering of intervention levels was different for each group. For the microworld group the rank ordering was as follows: Verbal instruction (3.45), Indicates materials (3.17), Demonstrates (1.98), and No intervention (1.40). For the alphabet group they were: Verbal instruction (3.28), No intervention (3.15), Indicates materials (2.38), and Demonstrates (1.20). Kendall's tests were also performed to see if mothers in each group agreed on an overall intervention strategy; this was found to be the case although patterns differed for each

group. In the microworld group ($W = .46, p \leq .0004$) the ranking of intervention levels was as follows: Demonstrates (3.24), Verbal instruction (2.81), Indicates materials (2.71), and No intervention (1.24). The alphabet group's mothers agreed on a different overall pattern: No intervention (3.85), Verbal instruction (2.70), Demonstrates (1.90), and Indicates materials (1.55).

Spearman Rank Correlations were performed between the age-of-child and rank ordering of intervention levels. Two relationships emerged in the microworld group: 1) The older the child, the more likely was mother to use verbal instruction ($R_s = .51, p \leq .017$). 2) The younger the child, the more likely was mother to intervene ($R_s = .51, p \leq .018$). No significant relationships between intervention level and age-of-child occurred for the alphabet group.

The region of sensitivity to instruction proved to be of little significance to this study. Binomial tests were used to determine this "region" for each child based on a 50 percent success rate. Pearson correlations between the number of times mother intervened at this level and the percent of child success were non-significant for both the microworld and alphabet groups respectively; $R = .30, p \leq .182$ and $R = .29, p \leq .199$.

A 2x2 ANOVA revealed no significant main effects for group or age on the posttest (sorting task). However, the age*group interaction approached significance.

Insert table 2. about here

Examination of the cell means by way of a simple main effects analysis (Keppel, 1982) revealed that no two means were significantly different at the $\alpha = .05$ level. However, the simple main effects for three-year-olds by group approached significance.

Insert table 3. about here

Visual inspection of these cell means showed that the three-year-olds in the microworld group sorted more objects correctly than the three-year-olds in the alphabet group.

Insert table 4. about here

Post hoc power calculations (Keppel, 1982) revealed this near significant difference to be due to the strength of the effect rather than chance. In other words, the lack of significance was due to the moderate number of subjects.

A mixed model repeated measures ANOVA [(A $\times$ (B $\times$ S))] revealed no significance for the day-of-week main effect or the age*day interaction. However, a highly significant main effect for age was discovered.

Insert tables 5. and 6. about here

Within the microworld group, three-year-olds correctly placed more graphic objects than did the two-year-olds on a daily basis. Visual inspection of the cell means bears this out.

Insert table 7. about here

The binomial tests used to determine the region of sensitivity to instruction by themselves yielded one last item of interest. Broadly defining success as the number of times correct keyboarding occurred, only 8 (.38) of the 21 dyads in the microworld group were successful more than 50 percent of the time. Only one of these eight dyads just reported contained a two-year-old. In the alphabet group 12 out of 20 (.60) were successful. Of these 5 (.42) dyads contained two-year-olds and 7 (.58) contained three-year-olds.

Conclusions and Discussion

Mothers Are Teachers. It can be concluded that mothers were entirely capable, even with the minimal training they received, of teaching and working with their preschool children at the computer; although the overall plan or strategy differed for each group. Considering the software differences, somewhat complex to incredibly easy, mothers behaved very much as was predicted. Microworld mothers paid

a good deal of attention to their children and adjusted their interventions from cues based upon the children's age and developmental abilities. Mothers adapted to the different situations they were exposed to remarkably well. Mothers in the microworld group began intervention by demonstrating and pointing and ended up either verbally instructing or doing nothing at all. Mothers in the alphabet group had less rigorous software with which to deal and consequently did less intervening. They made no change in strategy over time and when they did intervene, which ranked second to nothing, they tended to use verbal instruction. These software differences were closely related to why it was concluded that mothers in microworld group relinquished more control over software operation to their children as time progressed. However, mothers in neither group proved to be very sensitive to feedback from their child's successes/failures nor the region of sensitivity to instruction. The overall agreement between mothers in each group as to intervention strategy does not agree with the children's rank orderings of intervention level. As indicated in the results section, children had the most success, regardless of group, with verbal instruction. From there the group differences are drastic with the second highest rank going to mother indicates (points) for the microworld group and no intervention for the alphabet group. Again, it became obvious that software differences had far reaching effects upon mother/child interactions.

Software and Interaction. Software impact on interactions between mother and child can be seen in mother's choice of intervention level. Microworld dyads interacted considerably more as evidenced by greater amounts of demonstration and verbal instruction, ongoing changes in overall strategy, and children's dependency upon mother in earlier states of the intervention. Children learned to work independently at the computer rather quickly with the alphabet software and mothers in that group exhibited no intervention or verbal instruction the most. In other words, the alphabet software was so easy to master that little was required of mother; when intervention was required verbal instruction was sufficient. Mothers in this group did little more than help their children reach the keyboard.

Age of First Introduction to the Computer. In spite of Barnes and Hill's (1983, p. 11) warning that "children must reach the stage of concrete operations before they are ready to work with microcomputers," three-year-olds in the microworld group did surprisingly well. They showed the greatest task persistence, the least frustration, experienced greater amounts of software-operative success, and learned to classify or sort significantly better than the two-year-olds and nearly significantly better than three-year-olds in the alphabet group. Microworld two-year-olds, on the other hand, classified no better than children in the other group. Two-year-olds also exhibited more frustration, less task persistence, and the least software-operative success. This

was evidenced in the simple but clear results of the Binomial tests performed. Twice as many children in the alphabet group were successful at the keyboard as in the microworld group.

Based upon these findings it can be concluded that age of first introduction to the computer is dependent upon software content and competencies required. Highly colorful, cartoon like graphics that respond to any key manipulation, such as used in the alphabet group, require little preparation, instruction, or specific computer skills. If a child can push a key, they can operate this type of software with a high degree of success. On the other hand, software with exploration oriented content that requires sequential manipulations of several keys requires particular competencies. Such software demands much of the child both cognitively and physically. From the findings of this study and the literature review, it was recommended that two-years of age and upward be considered an appropriate time to introduce children to the computer and teach simple computer skills such as turning the machine on/off, making choices within software limitations, and simple graphics manipulations. Software to accomplish these tasks should be chosen with the goal of providing a pleasant, positive, and non-frustrating experience for the child. Single-key operated software, such as used in the alphabet group, is perfect for this. It is further recommended that three-years of age be earmarked as the appropriate time for increased

computer training and the introduction of discovery-based microworld software. It was shown that children at this age were capable of increased sophistication in terms of content as well as keyboard manipulations.

Microworlds. Based on the superior performance of three-year-olds over two-year-olds in the microworld group and their superior performance, even if not statistically significant, over the alphabet three-year-olds, it can be concluded that microworlds have great potential for enhanced cognitive development. As pointed out by Ziajka (1983), "someday we may want to add computer-generated images on a screen as a new form of representation that the child evokes and manipulates (p. 66)." He adds this possibility to an already long list of potential computer-based benefits to children; although some would argue otherwise (Barnes & Hill, 1983). For this sample, it appeared as though the three-year-olds had little difficulty in dealing with the computer abstractions. This corresponds to the prediction made by Piestrup (1985) when she noted that microcomputer presentation of material is really no more abstract than picture books (the staple of early childhood education) and far less static. Another major difference was that the abstractions presented via computer represented objects with which the children dealt everyday and as such were not far removed from their actual experience. This feature is critical to the formation of microworlds and distinguishes them from other software formats. Papert (1980a) stated that

microworlds should be "syntonic" or adaptive to the social or interpersonal environment. In other words, an idea is powerful for a person if it relates and unifies knowledge gained in diverse experiences (Lawler, 1982b). Microworlds are powerful ideas because they contain phenomenon which relate to the persons experience and embody the simplest model that an expert can imagine as an acceptable entry point to richer knowledge (Lawler, 1982a). As such they incorporate much of what Piaget (1970) and others (Ginsburg & Oppen, 1978) have identified as essential to cognitive development: opportunities to explore and consequently assimilate and accommodate to new cognitive structures. As Piaget (1971) has stated:

If we desire to form individuals capable of inventive thought and of helping the society of tomorrow to achieve progress, then it is clear that an education which is an active discovery of reality is superior to one that consists merely in providing the young with . . . readymade truths to know with (p. 259).

Furthermore, Papert (1980b) is certain the microworld will stimulate cognitive development by greatly increasing the number of relevant experiences in a child's life. Expose a child to 500 four-legged animals via a highly salient microworld where the child, through keyboard control, can manipulate the concept and who knows what may happen. In that light, these findings are indeed significant. On the

other hand, it must be pointed out that the results of this study may represent nothing more than a chance occurrence (replication is required). If so, the end result of the current emphasis on computer research (Brady & Hill, 1984) may prove the computer to be no more powerful than a pencil. Nevertheless, research on computer applications to young children will have helped to develop a powerful educational tool that makes little demands and gives much (Papert, 1980a).

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Table 1

Crosstabulation for Subjects by Age (2) and Sex (2)

Sex	Age		Row Total
	Two's	Three's	
	+	+	+
Male	9	14	23
			56.1
Female	12	6	18
			43.9
Column Total	21 51.2	20 48.8	41 100.0

Table 2

Analysis of Variance Summary for Total ObjectsClassified by Group (2) by Age (2)

Source	SS	df	F	Prob.
Group	5.015	1	0.3759	0.544
Age	0.622	1	0.0466	0.830
Group*Age	53.121	1	3.9820	0.053
Error	493.474	37		

Table 3

Simple Main Effects of Total Objects Placed
for Age=3 by Group (2)

Source	df	SS	F	Prob.
Between Groups	1	46.0626	3.0069	.1000
Within Groups	18	275.7374		

Table 4

Means and Standard Deviations of TotalObjects Classified by Group (2) by Age (2)

Variable	Mean	SD	n
Microworld	7.3333	3.4400	21
Two's	6.3000	3.7431	10
Three's	8.2727	3.0030	11
ABC Group	6.6500	4.0429	20
Two's	7.8182	3.0271	11
Three's	5.2222	4.8161	9

Table 5

Repeated Measures Anova Between-groups Effectsof Total Objects Placed for Day (4) and Age*Day

Source	SS	df	F
Day	2.06180	3	.20700
Age*Day	15.68084	3	1.57432
Error	189.24773	57	

Table 6

Repeated Measures Anova Within-Group Effects
of Total Objects Placed for Age (2)

Source	SS	df	F
Age	492.39058	1	25.61359 *
Error	365.25227	19	

*p<.0005

Table 7

Means and Standard Deviations for Total
Objects Placed by Day (4) by Age (2)

	Age	Mean	SD	n
Day # 1				
	2	3.00000	3.92428	11
	3	6.40000	2.71621	10
Day # 2				
	2	2.36364	3.04213	11
	3	7.40000	2.87518	10
Day # 3				
	2	1.63636	1.85864	11
	3	7.30000	2.58414	10
Day # 4				
	2	1.90909	2.16585	11
	3	7.20000	1.68655	10